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PUBLIC HEALTH REPORTS.

UNITED STATES.

[Reports to the Surgeon-General, Public Health and Marine-Hospital Service.]

Experiments in the culicidal effect of camphor-phenol and sulphur on mosquitoes.

Passed Assistant Surgeon Francis, at Mobile, Ala., reports, March 11 and 15, as follows on the result of experiments in mosquito destruction.

RESULTS IN 42 TABULATED EXPERIMENTS IN THE CULICIDAL EFFECTS OF CAMPHOR-PHENOL ON 10,000 MOSQUITOES.

In experimental work with culicides it is first necessary to establish certain tests. We must determine under what conditions the mosquitoes will be placed while they are being exposed to the fumes. The artificial protections which we throw about them should simulate as nearly as possible those which the mosquito brings to his rescue in nature.

What obstructions to the penetration and diffusion of fumes do mosquitoes find?

We know that mosquitoes hide among the clothes in wardrobes, get into the dark places in cupboards, hide behind washstands, under bureaus, desks, beds, bath tubs, and the bunks in staterooms on ships.

I found Stegomyia *fasciata* larvæ in dark jugs in 15 instances. Some adult females must have gone down through the narrow neck of the jug to deposit their eggs in the water.

There are doubtless other hiding places of mosquitoes of which we do not know and allowance should be made for them.

Possibly a mosquito which is 15 days old and has fed on blood is more able to withstand fumes than one which is only 1 or 2 days old. I believe that the *Stegomyia* is more resistant than *Culex pungens*. I think that no less severe a test should be required of a culicide than that after acting for 2 hours it should kill outright all mosquitoes placed in a cage on the floor beneath a bed the sides and ends of which are covered with blankets falling to the floor except on one side, on which the blanket lacks 4 inches of reaching the floor.

In this test it is not expected that the fumes will penetrate the blankets, for they possess no power of penetration. It is the diffusion of the fumes that is being tested. The fumes are expected to diffuse through the 4-inch opening on one side of the bed.

This test was suggested by the conditions found on shipboard, where mosquitoes hide beneath the bunks in staterooms. If we admit this test, which I believe is a reasonable one, then camphor-phenol in the proportion of 1 pint to 1,000 cubic feet, generated in a sealed room in an open pan, failed on February 5 and 6, when the outside temperatures were 43° and 42°.

The mosquitoes, after an exposure of two hours, were carried into the fresh air and were found flying the next day.

We made the test less severe and threw no protection about the mosquitoes, but exposed the cage in the open, on the floor, and we found that on March 8 and 9, when the temperature was 70°, 10 ounces of camphor-phenol per 1,000 cubic feet, generated in a sealed room, with an exposure of two hours to the fumes, allowed 2 mosquitoes to fly on the next day.

An examination of the results herewith reported of 42 experiments with camphor-phenol show that in only 10 experiments were all the mosquitoes dead at the end of two hours' exposure.

In 25 of the experiments some of the mosquitoes were alive several hours after the rooms were opened, and in 16 experiments some of the mosquitoes were found alive the next day.

In 21 experiments the mosquitoes were found more active several hours after the fumigation than at the time of removal from the fumes, showing that they recovered from the effects of the fumes.

The camphor-phenol was made as follows: The phenol crystals were liquefied by placing the bottles in boiling water; the liquid was then poured into a pan and weighed, and to the hot liquid was added an equal weight of gum camphor, which became dissolved after standing a few hours.

The cages which contained the mosquitoes consisted of tin coffee buckets, the lids and bottoms of which had been cut out and replaced with cheese cloth, such as is furnished for surgical dressings, and has 35 threads to the inch.

During the fumigation the cages were placed on their sides on the floor.

The generators used were of two kinds. The first which I will mention is the retort and blower. It consists of a formaldehyde autoclave, the top parts of which have been removed and replaced with a hood, on one side of which is an inlet for a draft of air from the blower, and on the opposite side of which is an exit through which the fumes pass into the room through a hole in a curtain stretched over a doorway or open window. The other generator consists of an open pan supported on a tripod, beneath which is an alcohol lamp.

In one set of experiments the mosquito cages were placed on the floor in the room, fully exposed to the fumes; in the other series the mosquito cages were placed beneath an ordinary ward bed, 3 feet in width by 6 feet in length; the bed, however, was covered on the ends and on one side by blankets which fell to the floor; the other side was covered by a blanket which lacked 4 inches of reaching to the floor. This open space of 4 inches by 6 feet was the only way by which the fumes could get under the bed. The outside temperatures cited in these experiments were not taken at the time the experiments were made, but were recently furnished to me from the records of the Weather Bureau at Mobile.

The inside temperatures were taken from a thermometer, which hung alongside of the mosquito cages.

On January 3 a china closet was fumigated with camphor-phenol, 125 c. c. per 1,000 cubic feet being generated by the retort and blower. Books were laid on the upper surfaces of the closet; at the end of the fumigation the books were removed and beneath them the varnish was dull, while the uncovered varnish had become bright, glossy, and sticky to the finger. On February 14 the gloss was still present and stood in marked contrast to the dull patches which were covered with books. Three hours after the room was opened on January 3 2 glass flower vases were placed on top of the closet, and on January 4 they had stuck fast and on being moved took off the varnish.

On December 21 camphor-phenol was generated by the retort and blower in the proportion of 250 c. c. per 1,000 cubic feet. When the room was opened the marble top of a stand had condensed the fumes into a heavy deposit of liquid, which could be wiped up with the finger. The woolen blankets on the bed were covered with a dew-like deposit, which made the hand wet when rubbed over them. A varnished dressing-table top was very sticky and glossy except beneath books, where the natural dull appearance of the top remained, and on February 14 the contrast between the bright, fumigated parts and the dull patches protected by the books was still apparent.

On January 4 a rough towel was placed on the dressing-table top and weighted with a book; the prints of the towel were distinctly apparent twenty-four hours later and were still visible on February 24. On January 4 some silver dollars were laid on the dressing table and on the next day they were quite firmly stuck. On January 11 a leather-bound book was laid on the dressing table, and the next day on removing it some of the soft leather had become fast to the varnish and tore loose from the book, and on February 14 it was still embedded in the varnish.

Drawn work, centerpieces, or thin pieces of paper, if left on horizontal varnished surfaces during a fumigation, where 250 c. c. of camphor-phenol per 1,000 cubic feet is used, would adhere to the softened varnish, and if left there to harden become permanently fixed, so that on attempting to remove them both the varnish and the articles would be ruined. Camphor-phenol does not leave a deposit on white bedspreads.

The fumes of camphor-phenol possess no power of penetration; they diffuse poorly, and they are diminished in efficiency by low temperature. Mosquitoes show a tendency to recover from the effects of the fumes. The amount necessary to kill mosquitoes in a cage, in the open, on the floor of a sealed room, was not determined.

Four, 6, 8, and 10 ounces per 1,000 cubic feet proved inefficient. The cost of 10 ounces is about 45 cents.

The fumes of 8 ounces of camphor-phenol per 1,000 cubic feet soften the varnish on horizontal surfaces.

Camphor-phenol generated in open pan.

[c. p.= *Culex pungens;* s. f.=*Stegomyia fasciata.*]

[1. Mosquitoes in cage on floor in the open.]

Date.	Cubic feet.	c. c. per 1,000 cubic feet.	Mosquitoes.	End 1 hour.	Opened at end 2 hours; mosquitoes removed.	Several hours later; mosquitoes in fresh air.	Next day.	Outside temperature.	Room temperature.	Room sealed.
								°	°	
Feb. 25	4,700	125	350 c. p.		No kicks.	34 kick.	No kicks.		70	Yes.
25	1,360	125	700 c. p.		2 spin, 1 dozen kick.	41 kick.	1 flies away, 1 walks, 5 spin.		70	Yes.
25	2,100	125	325 c. p.		do.	5 spin, 45 kick.	1 flies away, 3 walk, 6 spin.		70	Yes.
26	4,700	180	175 c. p.		No kicks.	No kicks.	2 spin, 2 kick.		73	Yes.
26	2,100	180	185 c. p.		do.	1 spins, 5 kick.	No kicks.		72	Yes.
27	1,360	180	285 c. p.		1 kicks.	1 flew away, 1 walks, 4 kick.	2 walk some, 4 kick.		73	Yes.
Jan. 21	1,360	240	130 c. p., 20 s. f.	1 dozen spin.	½ dozen kick.	2 s. f. jump, 8 s. f. kick, 8 c. p. kick.	No kicks.	53		Yes.
22	1,360	240	180 c. p., 8 s. f.	do.	8 s. f. spin.	1 s. f. walks, 2 s. f. spin, 5 s. f. kick.	1 s. f. kicks.	57		Yes.
23	1,360	240	200 c. p., 6 s. f.	do.	1 s. f. spins, 4 c. p. kicks.	No kicks.	No kicks.	59		Yes.
24	1,360	240	250 c. p., 50 s. f.	2 dozen spin.	8 s. f. spin, 1 c. p. spins, 100 c. p. kick.	1 dozen s. f. spin, 1 dozen c. p. spin.	1 s. f. walks, 1 c. p. walks.	62		Yes.
Feb. 24	4,700	240	425 c. p.		No kicks.	No kicks.	No kicks.		70	Yes.
Mar. 1	1,360	240	135 c. p.		do.	do.	do.		70	Yes.
1	2,100	240	335 c. p.		do.	1 flew away, 3 spin, 20 kick.	do.		70	Yes.
9	2,100	300	500 c. p.		3 spin.	1 flies, 3 spin, 31 kick.	1 flew away, 11 kick.		70	Yes.

[2. Mosquitoes in cage on floor beneath bed, the sides and ends of which are coverd with blankets which fall to the floor except on one side, on which the blanket lacks 4 inches of reaching floor, to simulate beneath the bunks of a ship.]

Date.	Cubic feet.	c. c. per 1,000 cubic feet.	Mosquitoes.	End 1 hour.	Opened at end 2 hours; mosquitoes removed.	Several hours later; mosquitoes in fresh air.	Next day.	Outside temperature.	Room temperature.	Room sealed.
Feb. 24	1,360	480	330 c. p.		½ dozen spin, ½ dozen kick.	1 walks some, 1 dozen spin, 16 kick.	1 walks some, 2 kick.		70	Yes.
Jan. 25	1,360	480	235 c. p., 33 s. f.	1 dozen spin.	3 s. f. spin, 2 c. p. spin.	1 s. f. kicks, 1 c. p. kicks.	No kicks.	60		Yes.
29	1,360	480	200 c. p.	do.	No kicks.	No kicks.	do.	60		Yes.
Feb. 4	1,360	480	125 c. p.	2 dozen spin.	2 dozen spin.	2 spin, 25 kick.	do.	51		Yes.
5	1,360	480	200 c. p., 2 s.f.	do.	do.	1 c. p. flies, 1 dozen jump.	1 dozen fly.	43		Yes.
6	1,360	480	150 c. p.		Half jump, spin, and sing.	2 dozen fly.	8 fly.	42		Yes.

Camphor-phenol generated in retort and blower.

[c. p. = ***Culex pungens;*** s. f. = ***Stegomyia fasciata.***]

[1. Mosquitoes in cage on floor in the open.]

Date.	Cubic feet.	C. c. per 1,000 cubic feet.	Mosquitoes.	End of 1 hour.	Opened at end of 2 hours; mosquitoes removed.	Several hours later; mosquitoes in fresh air.	Next day.	Outside temperature.	Room temperature.	Room sealed.
								°	°	
Sept. 25	3,300	100	120		2 kick			77		No.
Oct. 19	5,000	100	130	1 spins	No kicks	No kicks	No kicks	78		No.
19	5,000	100	100	2 spin	do	do	do	77		No.
Jan. 2	4,700	125	50 c. p., 3 s. f.	1 dozen spin	1 s. f. kicks	1 s. f. kicks, 1 c. p. kicks	1 kicks	65		No.
2	4,200	125	40 c. p., 10 s. f.	½ dozen jump	½ dozen kick	No kicks	No kicks	64		No.
3	4,200	125	32 c. p., 8 s. f.	2 spin, 2 kick	No kicks	do	do	71		No.
8	4,200	125	125	1 spins	do	do		73		No.
Feb. 21	1,360	125	225 c. p.	½ dozen spin	1 dozen spin	1 spins, 14 kick	No kicks		46	Yes.
23	1,360	125	310 c. p.	1 dozen spin	No kicks	No kicks	do		53	Yes.
Mar. 2	2,100	125	325 c. p.		10 spin	24 spin, 45 kick	1 flew away, 4 spin, 22 kick.		70	Yes.
4	1,360	180	375 c. p.		No kicks	No kicks	No kicks		70	Yes.
5	2,100	180	275 c. p.		1 spins	10 spin, 7 kick	1 flew away, 1 flies some, 9 kick.		70	Yes.
6	2,100	240	300 c. p.		do	1 spins, 9 kick	2 kick		72	Yes.
7	2,100	240	600 c. p.		2 dozen twitch	1 flew away, 14 spin, 110 kick.	1 flies some, 61 kick		73	Yes.
8	2,100	300	400 c. p.		2 spin, 9 kick	1 flies, 1 walks, 18 spin	1 flies, 1 walks		70	Yes.

1 flies normally in cage, March 8, 9, 10. 1 flies normally in cage, March 10, 11, 12.

[2. Mosquitoes in cage on floor beneath bed the sides and ends of which are covered with blankets which fall to the floor except on one side, on which the blanket lacks 4 inches of reaching floor, to simulate beneath the bunks on a ship.]

Date.	Cubic feet.	C. c. per 1,000 cubic feet.	Mosquitoes.	End of 1 hour.	Opened at end of 2 hours; mosquitoes removed.	Several hours later; mosquitoes in fresh air.	Next day.	Outside temperature.	Room temperature.	Room sealed.
Dec. 19	4,200	250	75 c. p.	2 dozen jump	1 spins		No kicks	47		No.
20	4,200	250	50	½ dozen jump	1 dozen jump	1 spins, 3 kick	do	52		No.
21	3,300	250	100 c. p., 20 s. f.	½ dozen spin	do	2 walk, 2 dozen jump	1 c. p. walks, 1 s. f. walks.	56		No.
21	4,200	250	50 c. p.		10 spin	No kicks	No kicks	61		No.
Feb. 22	1,360	250	280 c. p.		No kicks	do	do		70	Yes.
16	1,360	480	200 c. p.		1 spins	do	do		43	Yes.
9	1,360	480	125 c. p., 2 s. f.		1 dozen jump	1 c. p. flies, 2 s. f. spin, 7 c. p. spin, 12 kick.	do	40		Yes.

RESULTS OF 24 EXPERIMENTS WITH SULPHUR AS A CULICIDE.

The particular interest attached to these experiments is that such small quantities of sulphur proved so effective in tests which demanded that the fumes should have good power of penetration and diffusion, and further that perfect results were obtained in spite of the facts that the rooms were unsealed and that the temperatures ranged from 45° to 79°, the one exception being noted on the day of a very strong northeast wind, when one mosquito escaped at the conclusion of the fumigation. The room used on this day had two double doors and six windows and there was ample opportunity for the escape of fumes.

I used roll sulphur, burned in pots, in unsealed rooms, in the proportions of 152, 200, 250, and 333 grams per 1,000 cubic feet.

The time of exposure was two hours from the time of the lighting of the sulphur with alcohol until the room was opened and the mosquitoes were removed to the fresh air. One hundred and fifty-two grams, or one-third of a pound, killed mosquitoes in a cage on the floor in an open space. Two hundred grams killed mosquitoes as follows: In a cage on the floor beneath a bed, the sides and ends of which were covered with blankets falling to the floor except on one side, on which the blankets lacked 4 inches of reaching the floor; in a cage in a pillow slip on the floor behind a wardrobe; in a cage in a pillow slip in the wardrobe among clothes; in a cage on the floor beneath the wardrobe; in a cage covered with a handkerchief in the wardrobe among clothes; in a cage covered with a handkerchief on the floor under the wardrobe.

Two hundred and fifty grams also killed mosquitoes in a cage in a pillow slip on the floor under a bed in the fourth room from the one in which sulphur was burned, and in a cage in a pillow slip on the floor in the fifth room from the one in which the sulphur was burned.

Three hundred and thirty-three grams, or a little less than three-fourths of a pound, killed mosquitoes in a cage in a pillow slip on the floor under a bathtub in the fifth room from one in which the sulphur was burned; in a cage on the floor beneath a bed, the sides and ends of which were covered with blankets falling to the floor except on one side, on which the blankets lacked 4 inches of reaching the floor, the bed being in the fifth room from the one in which the sulphur was burned.

The following is a good rule for the use of sulphur:

Only roll sulphur should be used, and no more rolls should be put in a pot than will make a single layer on the bottom.

The rolls vary in diameter from 1½ to 1¾ inches. If powdered sulphur is used instead of the rolls, the fire in pot is very likely either to go out or take a long time in burning out. If more sulphur is put in the pot than a single layer of rolls, the pot will not burn out in two hours.

Sulphur burned in pots—doors and windows unsealed.

[c. p.= *Culex pungens;* s. f.=*Stegomyia fasciata.*]

[1. Mosquitoes in cage on floor in the open.]

Date.	Cubic feet.	Grams per 1,000 cubic feet.	Mosquitoes.	Opened at end 2 hours; mosquitoes removed.	Several hours later; mosquitoes in fresh air.	Next day.	Outside temperature.
							°
Sept. 25	5,000	152	115	No kicks	No kicks	No kicks	79
Jan. 24	4,700	152	150 c. p., 30 s. f.	do	do	do	60
23	4,700	152	100 c. p., 2 s. f.	do	do	do	63
22	4,700	152	150 c. p., 3 s. f.	do	do	do	60
21	4,700	152	150	do	do	do	55
20	4,700	152	100 c. p., 6 s. f.	1 flew away, 2 c. p. walk.	do	do	53

Room has two double doors and six windows. Very strong northeast wind blowing.

[2. Mosquitoes in cage on floor beneath bed the sides and ends of which are covered with blankets which fall to the floor except on one side, on which the blanket lacks 4 inches of reaching floor, to simulate beneath the bunks on a ship.]

							°
Dec. 21	4,700	200	64 c. p., 18 s. f.	No kicks	No kicks	No kicks	55
22	4,700	200	80 c. p., 10 s. f.	do	do	do	46
Jan. 10	4,700	200	90	do	do	do	72
11	4,700	200	100	do	do	do	64

[3. Mosquitoes in cage in pillow slip on floor behind wardrobe.]

Nov. 8	4,700	200	85	No kicks	No kicks	No kicks	71
9	4,700	200	75	do	do	do	70

[4. Mosquitoes in cage in pillow slip in wardrobe among clothes.]

Nov. 9	4,700	200	40	No kicks	No kicks	No kicks	70

[5. Mosquitoes in cage in wardrobe among clothes.]

Nov. 5	4,700	200	125	No kicks	No kicks	No kicks	71

[6. Mosquitoes in cage on floor beneath wardrobe.]

Nov. 5	4,700	200	50	No kicks	No kicks	No kicks	71

[7. Mosquitoes in cage covered with handkerchief in wardrobe among clothes.]

Nov. 7	4,700	200	150	No kicks	No kicks	No kicks	70

[8. Mosquitoes in cage covered with handkerchief on floor under wardrobe.]

Nov. 7	4,700	200	130	No kicks	No kicks	No kicks	70

[9. Mosquitoes in cage in pillow slip on floor under bed in fourth room from one in which sulphur is burned.]

Nov. 12	9,000	250	100	No kicks	No kicks	No kicks	48

Sulphur burned in pots—doors and windows unsealed—Continued.

[10. Mosquitoes in cage in pillow slip on floor in fifth room from one in which sulphur is burned.]

Date.	Cubic feet.	Grams per 1,000 cubic feet.	Mosquitoes.	Opened at end 2 hours; mosquitoes removed.	Several hours later; mosquitoes in fresh air.	Next day.	Outside temperature.
							°
Nov. 12	9,000	250	75	No kicks	No kicks	No kicks	48

[11. Mosquitoes in cage in pillow slip on floor under bath tub in fifth room from one in which sulphur is burned.]

Nov. 14	9,000	333	85	No kicks	No kicks	No kicks	59

[12. Mosquitoes in cage on floor beneath bed the sides and ends of which are covered with blankets which fall to the floor except on one side on which the blanket lacks 4 inches of the floor. Bed is in fifth room from one in which sulphur is burned.]

Dec. 17	9,000	333	150 c. p	No kicks	No kicks	No kicks	53
18	9,000	333	60	do	do	do	45
19	9,000	333	60 c. p	do	do	do	47
20	9,000	333	30 c. p	do	do	do	51

Reports from Vanceboro, Me.—Smallpox on Canadian border—Train inspection.

Acting Assistant Surgeon Young reports, March 10, as follows:

Week ended March 9, 1907. Inspected 18 passenger trains, carrying about 700 passengers, vaccinated 28, accepted official certificates of vaccination and nonexposure to infection in the case of 30.

The situation in infected districts is improving.

Week ended March 15, 1907. Inspected 18 passenger trains, carrying about 950 passengers, vaccinated 60, accepted official certificates of vaccination and nonexposure to infection in the case of 43. An epidemic of smallpox has developed in and around Charlottetown, Prince Edward Island, the infection having been conveyed there from Springhill, Nova Scotia.

Report from Mississippi River Quarantine Station, La.—Yellow fever on steamship Cayo Soto.

The following is received from Dr. C. H. Irion, president of the Louisiana State board of health:

March 20. Doctor Lamb, quarantine physician Mississippi River station, wires as follows: Steamship *Cayo Soto*, from Cuban ports via Mexican ports, had one case yellow fever en route; now convalescent. Am giving thorough fumigation and holding vessel for observation in accordance with State and National regulations.

Itinerary of steamship Cayo Soto.

Passed Assistant Surgeon Stansfield, at Habana, reports as follows:

March 22. *Cayo Soto* arrived from London via Bermuda, February 18. Obtained bill health February 22. Picked up customs officer at